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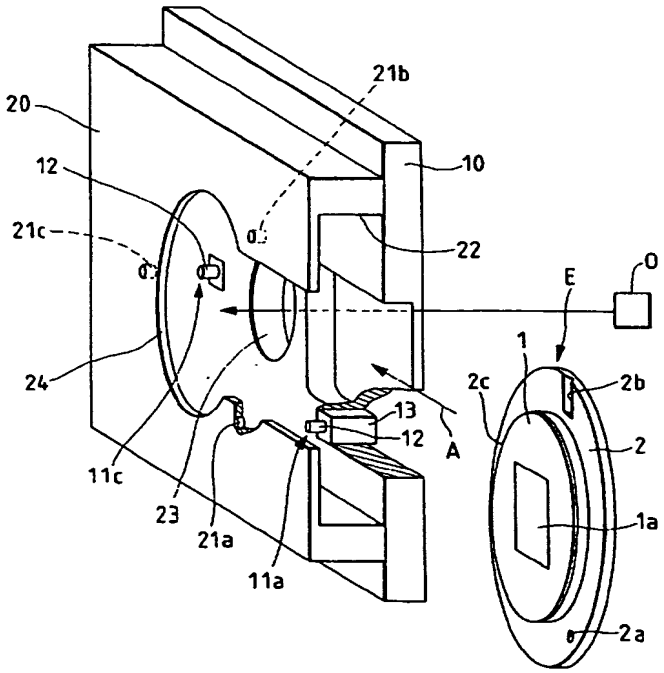
(54) Holding mechanism, and exposure apparatus using the mechanism

(57) A holding mechanism comprises a box body (10,20) for providing a space for accommodating an original (E), an opening (22) formed in a side portion of the box body, for inserting the original into the space, and holding means (11a-c,21a-c) for holding the original within the space by a kinematic mount system. An exposure apparatus can use the holding mechanism.

FIG. 1



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Description

The present invention relates to a holding apparatus capable of stably holding an original such as a mask, etc. without employing a magnet or a vacuum chuck in a semiconductor exposure apparatus, and an EB writing apparatus or a pattern dimension measuring apparatus, etc.

An original such as a mask, etc. of a semiconductor exposure apparatus advancing in terms of a hyperfine structure with X-rays serving as exposure light beams, is generally manufactured by steps shown in FIGS. 8A - 8F. To be specific, as illustrated in FIG. 8A, an SiC film M is deposited on at least one side of a substrate S composed of silicon. Then, as shown in FIG. 8B, a central portion of the substrate S is removed by back-etching, thereby forming an opening R covered with the SiC film (membrance) M. Thereafter, as depicted in FIG. 8C, an undersurface of the substrate S is bonded to a mask frame H, and, as shown in FIG. 8D, a pattern P of heavy metal is formed on the SiC membrane M at the opening R by a known EB writing method or by plating. Subsequently, as illustrated in FIG. 8E, a magnetic ring G is mounted on the undersurface of the mask frame H. When the thus manufactured mask is fixed to a mask stage T of the semiconductor exposure apparatus, as shown in FIG. 8F, the magnetic ring G on the undersurface of the mask frame H is adsorbed by a permanent magnet or electromagnet W on the mask stage T.

Incidentally, in a step of forming the pattern P of the mask, or alternatively in a step of measuring a pattern dimension after completely manufacturing the mask, electron beams are used, and hence a mask chuck involving the use of the permanent magnet and the electromagnet can not be employed. Instead, the mask is fixed by use of a known vacuum adsorption device, a spring clamp and so forth.

When the mask is thus fixed by employing the vacuum adsorption device and the spring clamp, however, a distortion different from a case of being fixed to the mask stage of the exposure apparatus by the magnet or the electromagnet, is caused enough to produce a large change in shape of the mask.

Under such circumstances, to obviate this problem, as illustrated in FIGS. 7A and 7B, there was developed a mask holding method based on a so-called kinematic mount system, by which the mask is clamped by three clamp forces Fa - Fc acting perpendicularly on the mask.

This method is that three pieces of balls Ba - Bc are applied onto the backsurface (or the upper surface) of a mask frame 102 of a mask 100; unillustrated clamp members are respectively made to approach the balls Ba - Bc; and the mask frame 102 of the mask 100 is clamped in between the respective balls Ba - Bc and the clamp members. Then, a position of the mask 100 in a perpendicular direction (a Z-axis direction) by the clamping forces Fa - Fc, respectively, and the first ball Bb engages with a conic groove 102a formed in the undersurface of the mask frame 102, thereby fixing only this portion within an X-Y plane perpendicular to the Z-axis. Subsequently, the second ball Ba slidable engages with a V-shaped groove 102b radially extending with respect to the conic groove 102a, thereby fixing a rotating position thereof. Note that the third ball Bc brought into contact with a flat portion of the undersurface of the mask frame 102, is rollable in arbitrary directions, and is constructed so as not to unnecessarily restrain the mask 100.

More specifically, the construction is such that the mask 100 is positioned in totally hexa-axes directions of X-, Y- and Z-axes, and ωX-, ωY- and ωZ-axes of the mask 100 by making use of only the clamping forces Fa - Fc acting respectively through the three balls Ba - Bc. This kind of kinematic mask can be stably held without applying an unnecessary restraining force to the mask, and, besides, the exposure apparatus, the EB writing apparatus and the mask holding apparatuses such as a pattern inspecting apparatus can be all constructed the same, thereby making it possible to prevent the change in shape of the transfer pattern. Accordingly, this is suited to the high-accuracy X-ray exposure apparatus and EB exposure apparatus as well.

It is an object of one aspect of the present invention, which was contrived to further improve a holding mechanism for holding an original by a kinematic mount system, to provide an excellent holding mechanism capable of miniaturizing the apparatus and surely holding the original at a high speed.

It is an object of another aspect of the present invention to provide an exposure apparatus having this holding mechanism, and a device manufacturing method making use of the exposure apparatus.

According to one aspect of the present invention, a holding mechanism comprises a box body for providing a space for accommodating an original, an opening formed at the side portion of the box body, and a holding mechanism for holding the original within the space by a kinematic mount system.

Herein, the holding mechanism further comprises three pieces of clamping mechanism, and three pieces of protrusions facing thereto. Further, the holding mechanism holds the original perpendicularly. Also, the opening has a first opening for inserting the original into the space, and a second opening for taking the original out of the space. Moreover, the box body has a hole for making an exposure energy reach the original held in the space.

According to another aspect of the present invention, an exposure apparatus comprises a holding mechanism having a structure for holding the original, and an exposing device for exposing the original held by the holding mechanism to the exposure energy.

Herein, the exposure energy is X-rays.

According to still another aspect of the present invention, a device manufacturing method comprises a step of transferring a pattern of the original onto a sub-

strate by use of the exposure apparatus and a step of fabricating a device using the exposed original.

Embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view illustrating a mask holding mechanism together with a mask in accordance with a first embodiment;
FIG. 2 is a perspective view showing a state where the mask is mounted on the apparatus shown in FIG. 1;
FIG. 3 is a perspective view illustrating the mask holding mechanism together with the mask in accordance with a second embodiment;
FIG. 4 is an explanatory view schematically showing a whole X-ray exposure apparatus;
FIG. 5 is a flowchart showing a processing flow based on a device manufacturing method;
FIG. 6 is a flowchart showing a detailed flow of wafer process;
FIGS. 7A and 7B are explanatory views showing a mask based on a kinematic mount system; and
FIGS. 8A, 8B, 8C, 8D, 8E and 8F are explanatory views showing a mask manufacturing process.

FIG. 1 shows an original holding apparatus in accordance with a first embodiment. This holding apparatus is employed for an exposure apparatus for exposing a wafer defined as a mask and a substrate with an exposure energy such as X-rays and electron beams generated from a radiation source O serving as an exposure device, and for exposure-transferring a mask pattern on the wafer. The holding mechanism includes a base 10 having three clamp units 11a - 11c (the clamp unit 11b is shown in FIG. 2) defined as a clamping mechanism, and a holding frame 20 having balls 21a - 21c (spherical protrusions) fixed in face-to-face positions of the respective clamp units 11a - 11c.

Formed in the interior of a box body consisting of the base 10 and the holding frame 20, is a space area defined as an original accommodation space enough to accommodate a mask E serving as an original based on the kinematic mount system. Further, an opening 22 for inserting the mask E into the space area in an arrowed direction A and taking out the mask E in the direction reversed thereto, is formed in one side surface of the holding frame 20 at the side portion of the box body. Formed also are a hole 23 for permitting the exposure energy given from the radiation source O to reach the mask held in the space area, and a hole 24 for enabling the mask pattern to be exposure-transferred onto the wafer substrate disposed in close vicinity to and in a face-to-face relationship with the mask.

On the other hand, the mask E includes an Si substrate 1 for retaining a membrane 1a having an unillustrated pattern at the central opening, and a mask frame 2 for holding an outer peripheral portion thereof. An upper surface, as viewed in the Figure, of the mask frame 2 is provided with a conic groove 2a, a V-shaped groove 2b and a plane surface 2c with which the mask holders 21a - 21c are capable of respectively coming into contact.

Each of the clamp units 11a - 11c is fixedly supported on the base 10 has a clamp member 12 protruding into a space area between the base 10 and the holding frame 20 in the interior of the box body, and a driving portion (an air cylinder) for moving the clamp member 12 up and down. The clamp member 12 is moved back and forth to the respective balls 21a - 21c defined as the protrusions fixed to the holding frame 20, thereby clamping the mask E and releasing the mask E from being clamped.

The following is a way of how the mask E is carried and mounted (positioned) on the mask stage. As illustrated in FIG. 2, the mask frame 2 for the mask E is grasped by a carry hand N and then inserted via the opening 22 of the holding frame 20 into the space area between the base 10 and the holding frame 20. Then, the conic groove 2a, the V-shaped groove 2b and the plane surface 2c of the mask frame are located just under the balls 21a - 21c. Subsequently, the clamp members 12 of the clamp units 11a - 11c are raised and protruded by driving the driving portions 13 thereof, and the mask frame 2 is pressed and thus clamped by clamping forces acting perpendicularly between the respective balls 21a - 21c. In this manner, the mask frame 2 for the mask E is fixed directly to the mask stage, and the mask E is held while standing vertically resisting the gravity. Then, the mask is positioned with respect to the wafer substrate, and the exposure-transfer is executed. Further, an operation of demounting the mask E from the mask stage after the exposure-transfer has been done, involves lowering the clamp members 12 by reversely driving the driving portions 13 of the individual clamp units 11a - 11c, and taking out the mask E in the direction opposite to the arrowed direction A.

Note that the driving portion of each clamp unit is not limited to the air cylinder but may involve the use of other double-acting type of actuators.

FIG. 3 illustrates the mask stage serving as the original holding apparatus in accordance with a second embodiment. This mask stage is formed with an opening 32b defined as a second opening for taking the mask E out of the interior of a holding frame 30 on the opposite side to a first opening 32a of the holding frame 30 similar to the holding frame 20 in the first embodiment. The mask E, the base 10, the clamp units 11a - 11c and the balls 21a - 21c are the same as those in the first embodiment and therefore marked with the like numerals, and explanations thereof are omitted. As indicated by an arrow A_1, the mask E is inserted into a space area between the base 10 and the holding frame 30 and the taken out of the second opening 32b as indicated by an arrow A_2.

The mask can be inserted and taken out in the same

direction substantially simultaneously, and hence there must be added such an advantage that a mask replacing operation can be speeded up. Other points are the same as those in the first embodiment.

According to the thus constructed present apparatus, the mask can be stably fixed directly to the mask stage of the exposure apparatus by the kinematic mount system through no intermediary of the mask holder having a large weight. It is thereby possible to simplify and miniaturize the mask carry device of the exposure apparatus to a large extent, and also improve a throughput by simplifying the mask replacing operation, etc.. Additionally, a replacing time can be easily reduced by substantially simultaneously inserting and taking out the mask. Moreover, the mechanism such as the mask stage that holds the mask is also simplified, and the dimension thereof in the heightwise direction can be largely reduced enough to prevent a damage to the mask when the mask falls down. As a result, the above construction might make a great contribution to the simplification and miniaturization of the mechanism of the whole exposure apparatus.

FIG. 4 is a schematic view of an X-ray exposure apparatus, showing one example of the exposure apparatus including the above-described mask holding mechanism. High-luminance X-rays emitted from a synchrotron ring 30 are magnified and directed to the X-ray exposure apparatus by a total reflection mirror of an X-ray mirror 31. An exposure quantity control moving shutter 32 controls an exposure quantity when transferred. The X-rays passing through a shutter 32 further travel through an X-ray mask 33 and are subjected to patterning upon a resist on a wafer 34. The X-ray mask 33 is held by the mask holding mechanism having the structure illustrated in FIG. 1 or 3.

FIG. 5 is a flowchart showing a processing flow of manufacturing a semiconductor device (a semiconductor chip such as IC and LSI, or a liquid crystal panel and CCD) by using the above-mentioned exposure apparatus. In step 1, (circuit designing), a circuit of the semiconductor device is designed. In step 2 (mask fabrication), a mask formed with the designed circuit pattern is manufactured. In step 3 (wafer fabrication), the wafer is manufactured by use of a material such as silicon etc.. Step 4 (wafer process) is termed a "pre-process", wherein an actual circuit is formed on the wafer based on the lithography technique by use of the prepared mask and wafer. Step 5 (assembly) is called a "post-process", wherein a semiconductor chip is formed by use of the wafer manufactured in step 4. Step 5 includes an assembly step (dicing, and bonding), and a packaging step (chip sealing). Executed in step 6 (inspection) are inspections such as an operation confirming test and a durability test of the semiconductor device manufactured in step 5. The semiconductor device is completed through the above steps and comes to loading (step 7).

FIG. 6 is a flowchart showing a detailed processing flow of the above-described wafer process. In step 11 (oxidization), the wafer surface is oxidized. In step 12 (CVD), an insulating layer is formed on the wafer surface. In step 13 (electrode formation), an electrode is formed by deposition on the wafer. In step 14 (ion implantation), ions are implanted into the wafer. In step 15 (resist process), a photosensitive agent is applied on the wafer. In step 16 (exposure), the mask circuit pattern is printing-exposed on the wafer by the exposure explained above. In step 17 (development), the exposed wafer is developed. In step 18 (etching), areas excluding the developed resist image are removed by etching. In step 19 (resist removal), the unnecessary resist after etching is removed. The circuit patterns are formed in multiple on the wafer by repeating the those steps.

It is apparent that, in this invention, a wide range of different working modes can be formed based on the invention without deviating from the scope of the invention.

Claims

1. A holding mechanism comprising:

   a box body providing a space for accommodating an original;
   an opening formed at the side portion of said box body; and
   a holding mechanism for holding the original within the space by a kinematic mount system.

2. The holding mechanism according to claim 1, said holding mechanism comprising:

   three pieces of clamping mechanism; and
   three pieces of protrusions facing thereto.

3. The holding mechanism according to claim 1, wherein said holding mechanism holds the original vertically.

4. The holding mechanism according to claim 1, wherein said opening has a first opening for inserting the original into the space, and a second opening for taking the original out of the space.

5. The holding mechanism according to any of claims 1 to 4, wherein said box body has a hole for making an exposure energy reach the original held in the space.

6. The holding mechanism according to claim 1, wherein the original is an X-ray mask comprising a substrate having a mask pattern and a frame for holding the substrate, and wherein the holding mechanism holds the frame of the X-ray mask.

7. An exposure apparatus comprising:

a holding mechanism having a structure, as set forth in claim 1, for holding said original; and exposing means for exposing said original held by said holding mechanism to the exposure energy.

8. The exposure apparatus according to claim 7, wherein the exposure energy is X-rays.

9. A device manufacturing method comprising:
a step of transferring a pattern of said original onto a substrate by using said exposure apparatus according to claim 7, and a step of fabricating a device using the exposed original.

10. A holding apparatus for holding an object such as an original for use in an exposure apparatus, the apparatus comprising:

a holder having an opening in a side thereof communicating with a hollow area within said holder for receiving said object, and
a holding mechanism for holding said object within said hollow area.

FIG. 1

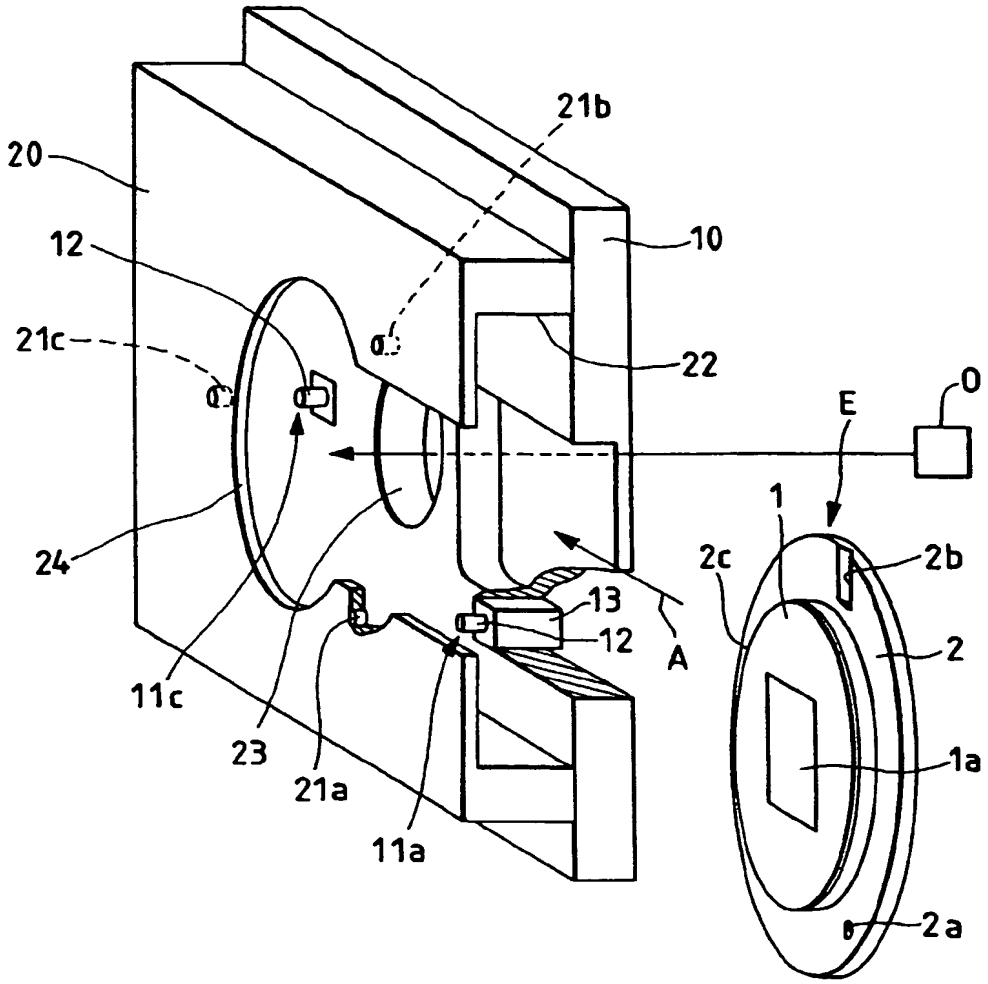

FIG. 2

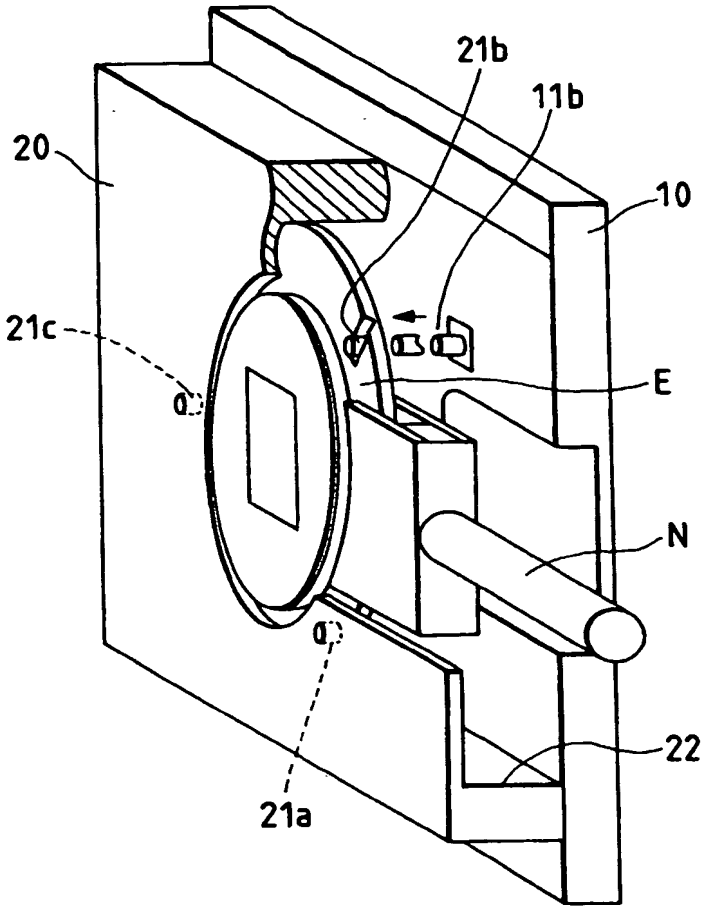

FIG. 3

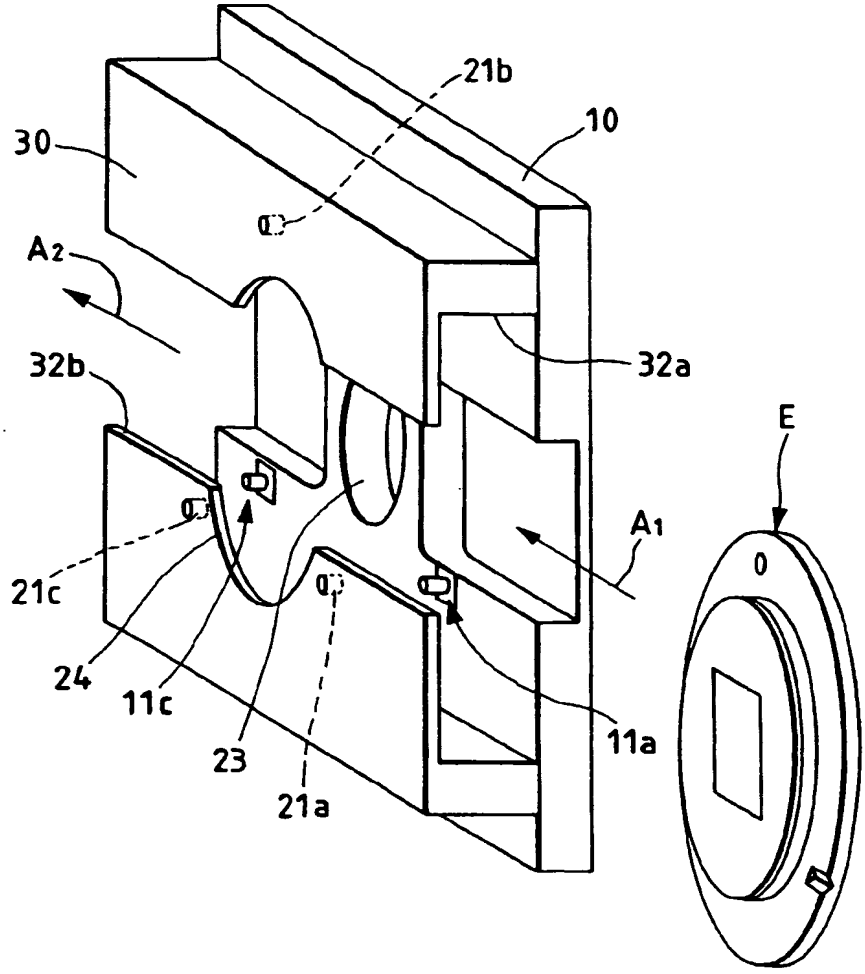

FIG. 4

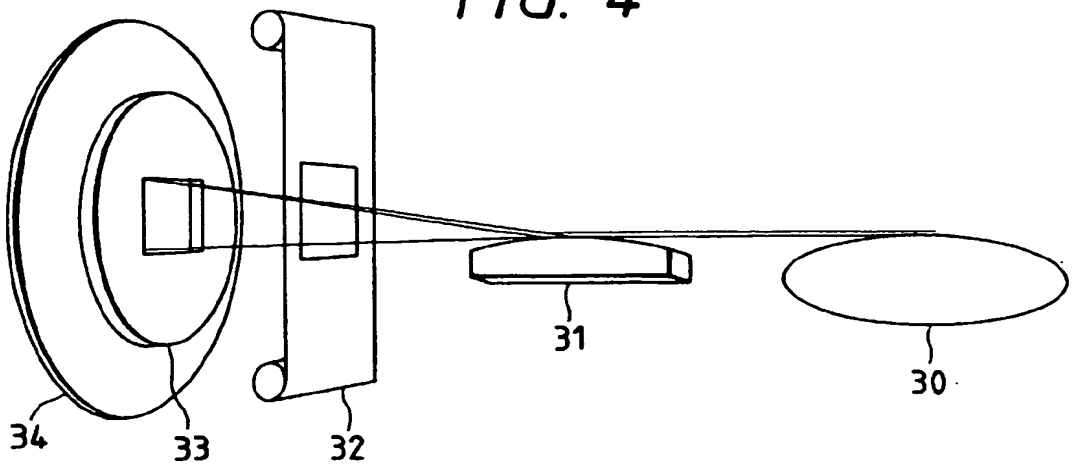

FIG. 5

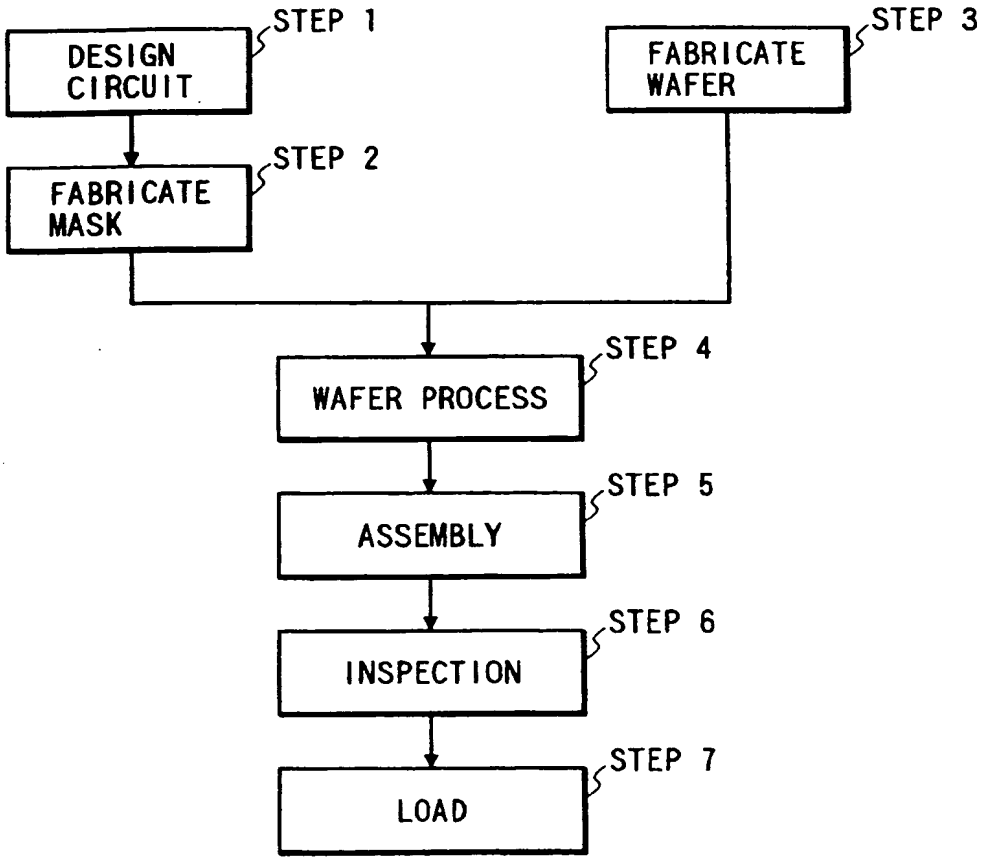

FIG. 6

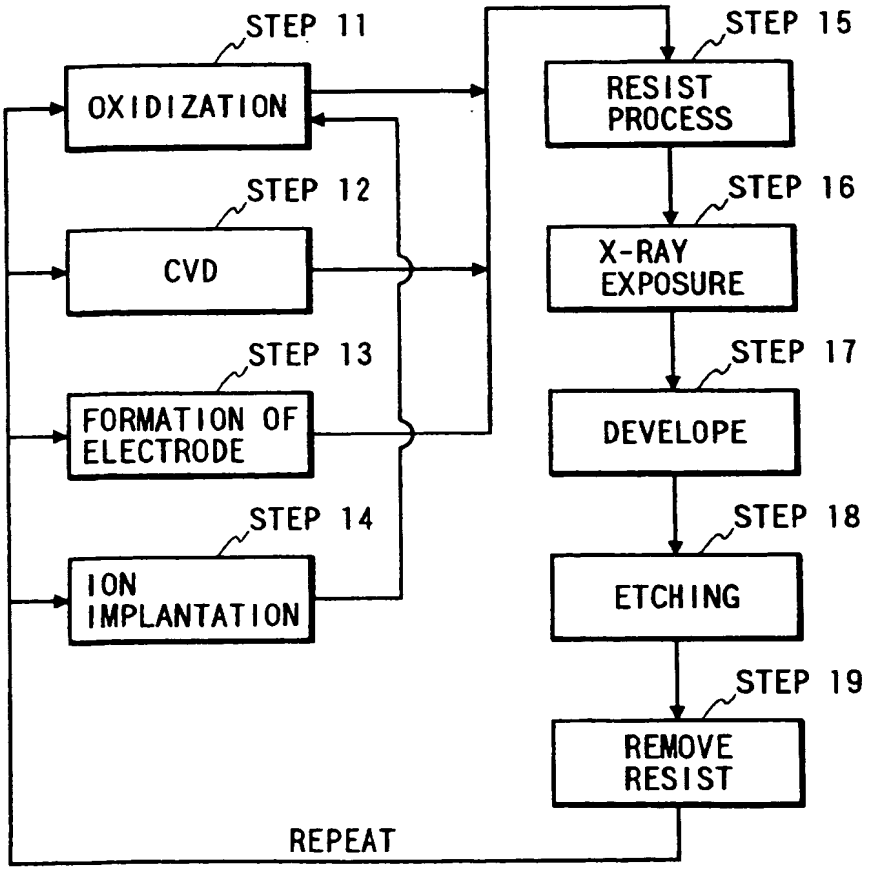
STEP 11
OXIDIZATION
STEP 12
CVD
STEP 13
FORMATION OF ELECTRODE
STEP 14
ION IMPLANTATION
STEP 15
RESIST PROCESS
STEP 16
X-RAY EXPOSURE
STEP 17
DEVELOPE
STEP 18
ETCHING
STEP 19
REMOVE RESIST
REPEAT

FIG. 7A

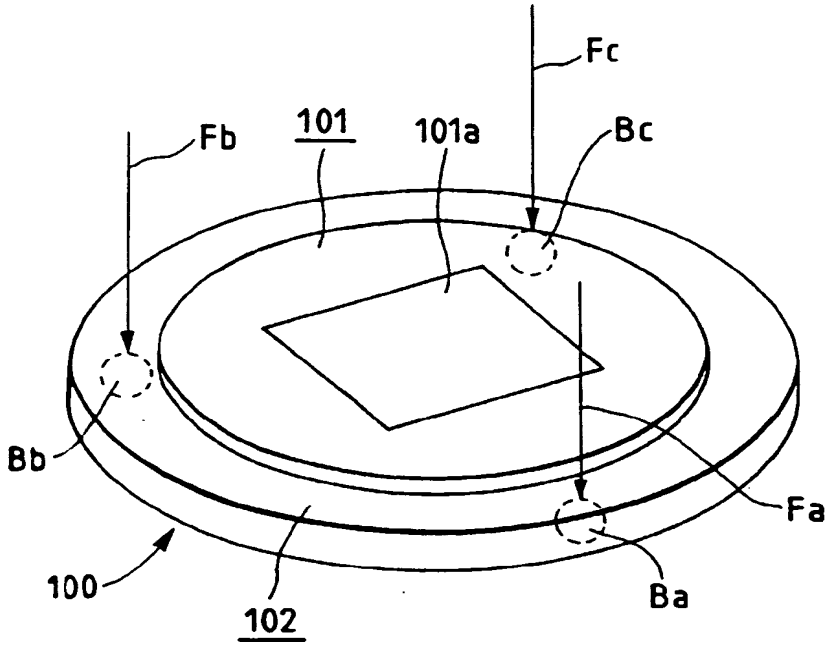

FIG. 7B

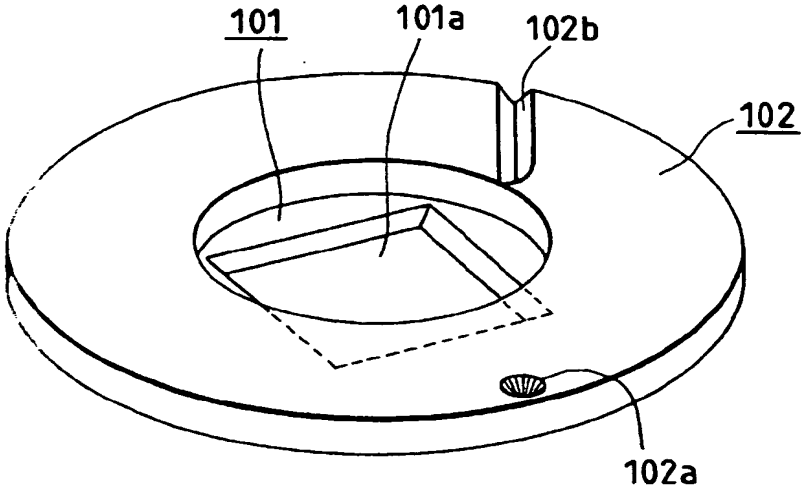

FIG. 8A

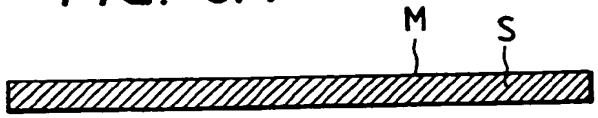

FIG. 8B

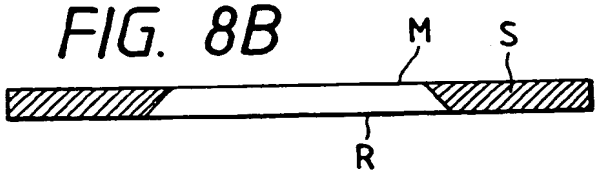

FIG. 8C

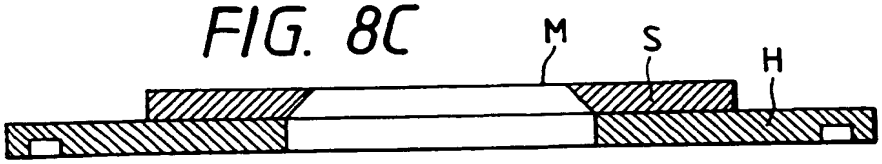

FIG. 8D

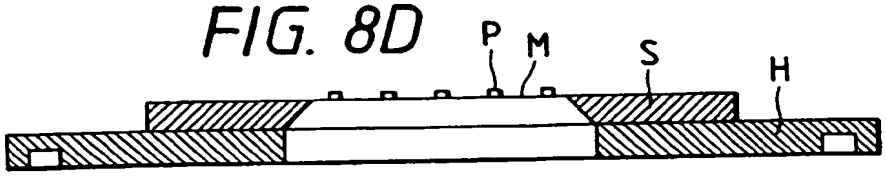

FIG. 8E

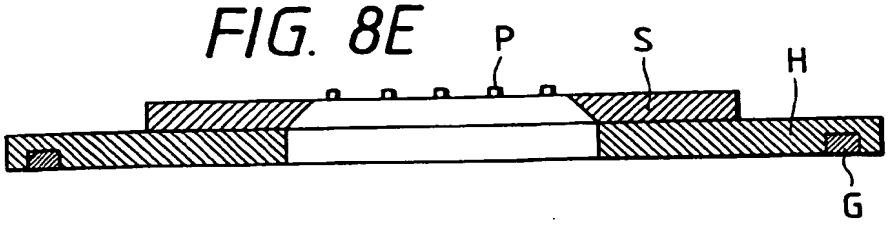

FIG. 8F

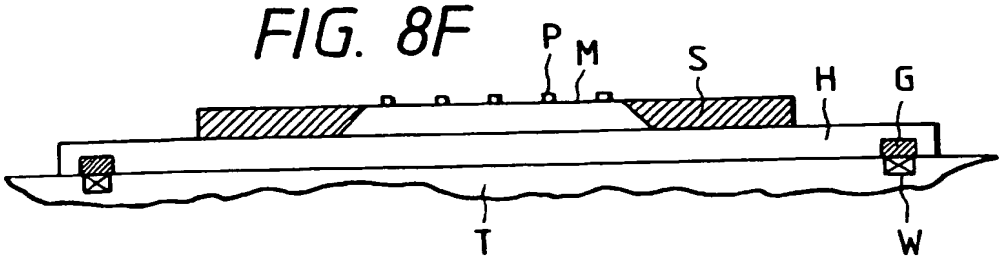

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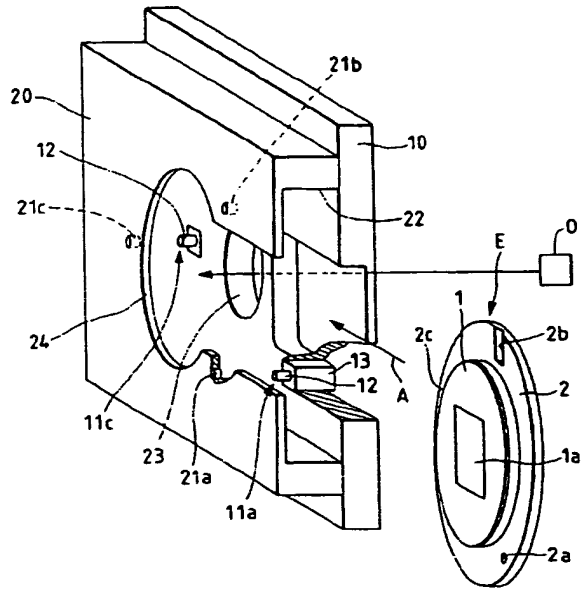
FIG. 1



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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 30 0731

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 425 739 A (CANON KK) • page 3, paragraph 1 * • page 24, line 7 - line 46 * • page 45, line 52 - page 46, line 23 * • figures 13,17 * • figures 27-31,77 *	10	G03F7/20 G03F1/14
Y	---	1-3,5-9	
Y	[illegible] D L ET AL: "PRACTICAL CONSIDERATIONS IN X-RAY MASK MOUNTING METHODOLOGY" JOURNAL OF VACUUM SCIENCE AND TECHNOLOGY: PART B, vol. 11, no. 6, 1 November 1993, pages 2953-2957, XP000423446 • page 2953 - page 2955 * • page 2957, left-hand column, line 7 - line 10 * • figures 1,2,4,5 *	1-3,5-9	
A	---	1,7,9	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	US 4 934 047 A (DESCHENAUX WARREN ET AL) • abstract; figures *	1,7,9	G03F
A	---	1,7,9	
A	US 4 539 695 A (LA FIANDRA CARLO) • abstract; figures *		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
[illegible]	23 January 1998	Heryet, C

CATEGORY OF CITED DOCUMENTS
X : particularly relevant if taken alone
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P : intermediate document

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